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# **FUNDAMENTAL CONCEPTS OF COST-BENEFIT ANALYSIS**

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19. ABSTRACT (Continue on reverse if necessary and identify by block number)  This handbook has been designed for use by problem solving groups such as Quality Circles and Total Quality Management Teams, and by others with no experience in performing Cost-Benefit Analysis. Its purpose is to describe the Cost-Benefit Analysis process, discuss the steps in preparing one, and identify the techniques used. Practical exercises illustrate the concepts and a glossary is included to define terms used.					
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**FUNDAMENTAL CONCEPTS**

**OF**

**COST-BENEFIT ANALYSIS**

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## **PREFACE**

Cost-benefit analysis is a complex technique. While the concepts are reasonable and straightforward, many of the methods and formulas employed are complicated. The term "benefit-cost analysis" can be used, because that's what the analysis really is. Most people, however, use the term "cost-benefit analysis." Either term is acceptable.

This handbook has been designed for use by problem solving groups such as Quality Circles. Its purpose is to describe the process, discuss the steps involved, familiarize you with the techniques, and point you in the direction of professional help when necessary. It is not intended to make you an expert nor do its proponents expect you to rely solely on this document when you perform such an analysis.

## I. ESTIMATING COSTS

### A. INTRODUCTION

The cost of an item is the sum of the amount spent for material, labor, overhead cost, and burdens associated with its production. Price is the cost of an item plus an associated profit. Price is what the government pays. Cost is the cost of production that a manufacturer experiences.

### B. CONCEPTS

There are many components to cost, and to obtain an accurate estimate of cost it is essential that all relevant components be included. Many cost estimates are deficient because the analyst fails to take into consideration certain hidden costs which are not obvious to the casual observer.

An additional consideration in the development of a cost estimate is the principle of parsimony or the KIS principle. The analyst should only capture the detail necessary to complete the cost estimate at the level of accuracy desired. The components of a cost estimate are estimates, and unnecessary deliberation concerning smaller cost items not only delays the production of the estimate but also may add very little to the accuracy of the final cost figure.

It is extremely important to have reliable data to support an estimate. Documentation allows the recipient to understand how the estimates were produced and show that they have been produced using good data and appropriate techniques.

Estimates can be produced in current or constant dollars. Current dollars are inflated dollars based on the year the estimate starts. Constant dollar estimates are uninflated estimates, in which no inflation has been included.

A number of Army publications provide guidance useful in the development of cost estimates:

<u>Publication</u>	<u>Title</u>
AR 70-64	Design to Cost
AR 11-18	The Cost Analysis Program
AR 11-28	Economic Analysis Program
AR 37-63	Standard Army Inflation Methodology [SAIM]

(Cont.)

<u>Publication</u>	<u>Title</u>
CM 90-08	TROSCOM Handbook of Army Cost Analysis Terms
CM 90-03	TROSCOM Design to Cost Handbook
CM 87-07	Inflation Indices-An Introduction to Basic Theory and Their Application.
CM 90-06	Troop Support Inflation Program

Cost Analysis Division performs cost analyses on task basis. In addition, assistance to other directorates which are performing cost analyses can be provided on an individualized basis by contacting the Cost Analysis Division, Directorate for Resource Management, at extension 3318.

#### C. ESTIMATING TECHNIQUES

##### 1. Catalog Prices

One of the best sources of cost data for small items is from catalog prices established in print. Contract Cost Division, Directorate for Procurement and Production, performs contract analyses of previous procurements and has access to contracts and some catalogs. Other catalog pricing data may be obtained directly from local and national suppliers. It is also possible to obtain data from the Army Master Data File (AMDF) available on microfiche.

##### 2. Cost Data Sources

A number of approved sources for cost data, factors, and forecasts exist. Several are listed below as examples:

<u>Source</u>	<u>Data Item</u>	<u>Justification</u>
Data Resources Inc.	Commodity Inflation Forecasts	DOD Contract
Defense Log Agency	Purchased Parts and Small Items	Official Agency
US Army	Force Planning Handbook	Army Publication
GMFA	Fuels Pricing News Letter	Official Data
OPM	GS/GM Pay Schedules *	Official Data
Cost Analysis Div	Fringe Benefits and Holiday Adjustment Factors	TROSCOM Data

\* Military Pay Schedules are also available.



### 3. Similar Item

When developing the cost for an item or system which has not been produced before, costing by analogy may be necessary. This entails the use of data concerning similar but not identical systems which have been produced in the past. This method of using previous prices from preexisting systems has the advantage that such cost data may be readily available. It has a definite disadvantage if the new item or system is technologically superior to those for which past data is available. Care has to be taken in the use and interpretation of such previous data.

### 4. Engineering Estimate

Estimates of cost may be obtained through engineering techniques which break a system into its components and develop costs by level of production or manufacture. Such detailed breakdowns, when available, are used to develop work packages which capture labor, material, and other costs identified by process of manufacture.

### 5. Parametric Estimate

Parametric estimation uses data concerning similar items or systems to develop cost estimates for new systems in a special way. Regression or forecasting techniques which use calculus and other mathematical tools are used to generate forecasting curves or lines from which cost estimates for the new systems may be read.

Several techniques are frequently used. One is called the Least Squares regression technique. Another is called the Moving Average technique. Both techniques are readily available as PC software. Much care should be taken in the use of this type of software so that the significance of the results is not misunderstood.

### 6. Random Sampling

Some statistics for cost estimating purposes may be obtained by the use of statistical sampling techniques. This method of data collection can be quite accurate if sample sizes are large and sampling periods are reasonably long. Sampling allows the analyst to develop estimates of cost parameters by examining small amounts of sample data. The theory of probability allows the analyst to make inferences as to the validity of the sample statistics.

### 7. Historical Data

The simplest method for developing the cost for an item or system is to use historical procurement data when it exists. For example, if 200 generators were purchased in 1987 at a given price and a new procurement price for 100 generators were desired, the previous cost could be updated. This involves two steps. Step one adjusts the unit price for 200 units to a unit price for 100 units. Step two moves this adjusted

cost in 1987 to the current year using historical inflation indices. The mathematical construct that is used to adjust for quantity differences is called the learning curve, and is found tabulated in several volumes available in the command library. The inflation indices used are developed by Cost Analysis Division, Directorate for Resource Management, and may be obtained from the TROSCOM Inflation Focal Point at extension 2357.

**D. TYPES OF COSTS**

**1. Development Cost**

Those costs primarily associated with the development of a new or improved capability to the point that it is ready for operational use.

**2. Investment Cost**

Those costs required beyond the development phase to introduce a new capability into operational use. To procure initial, additional or replacement equipment for functional users or to provide for major modifications of an existing capability.

**3. Operating and Support Cost**

Those costs necessary to operate, support, and maintain a capability. These costs include personnel, and operation and maintenance.

a. Operating Costs - This includes the cost of spares, parts, and supplies, utilities costs and the cost of initial training.

b. Personnel Costs - This category includes direct (functional) pay and allowances, indirect (support) pay and allowances and supplemental training.

c. Maintenance Costs - This category includes labor and material cost relating to preventative maintenance as well as repair, material modification costs, and other maintenance support costs.

The information provided above is quite general in nature. Accurate estimates require judicious application of life cycle costing techniques. These are defined in the following documents:

<u>Document Number</u>	<u>Title</u>
DA Pam 11-2	Research and Development Cost Guide
DA Pam 11-3	Investment Cost Guide
DA Pam 11-4	Operating and Support Cost Guide
DCA-P-92(R)	Instructions For Reformatting the BCE/ICE

#### 4. Lease Versus Buy Options

Some costs are comparative in nature. In some instances it is to the government's advantage to lease rather than buy equipment. The development of a lease cost is based on the concept of using only a portion of the value of an asset. Lease costs are calculated by developing estimates of length and amount of use, repair and maintenance, refurbishment, and restoration. The lease cost of these items is generated by developing an overall picture of how the item will be used, where it will be taken, and the conditions under which it will be returned.

#### E. ILLUSTRATION

Here is a familiar example of a cost analysis in its simplest form: Your current car, Old Not-So-Faithful, is costing you a lot of money to keep running. You drive 25,000 miles a year, and are only getting 15 miles per gallon (paying \$1.25 a gallon). You need to spend \$2,000 for an overhaul if you keep the car, and your mechanic assures you there will be \$500 annually in repairs even after the overhaul. But, the old car is paid for.

A new model, the El Cheapo Supreme, is very efficient to operate -- it gets 40 miles per gallon (the same kind of gas) and you have been offered a "terrific deal." If you trade in your old car, the dealer will lease you a new El Cheapo Supreme for ONLY \$300 a month which includes all maintenance. The lease would last three years.

Let's do a cost analysis of this situation.

What is the "life-cycle of the project?" Well, the lease period would be three years, and at an average of 25,000 miles per year, Old Not-So-Faithful will be worn out in another three years anyway. So let's use three years as the life-cycle.

#### Alternative A: El Cheapo Supreme

\$ 300 per month (including maintenance)  
x 36 months  
\$ 10,800 cost of 3 year lease

25,000 miles per year  
x 3 years  
75,000 miles driven

75,000 miles divided by 40 mpg = 1,875 gallons of gas.

1,875 gallons  
x \$1.25 price per gallon  
\$ 2,343.75 cost of gas

\$10,800.00 lease cost  
 + 2,343.75 cost of gas  
 \$13,143.75 total 3 year cost of El Cheapo Supreme

Alternative B: Old Not-So-Faithful

\$ 2,000 cost of overhaul  
     500 1st year repairs/maintenance  
     500 2nd year repairs/maintenance  
 + 500 3rd year repairs/maintenance  
 \$ 3,500

25,000 miles per year  
 x 3 years  
 \$ 75,000 miles driven

75,000 miles divided by 15 mpg = 5,000 gallons of gas.

5,000 gallons  
 x \$1.25 price per gallon  
 \$ 6,250 cost of gas

\$ 3,500 repair/maintenance cost  
 + 6,250 cost of gas  
 9,750 total 3 year cost of Old Not-So-Faithful

So, how do the costs of leasing a new car compare to keeping the old one? Without doing a cost analysis, would you have guessed that the costs of the El Cheapo Supreme would outweigh the costs of the Old Not-So-Faithful by over \$3000? (\$13,143.75 - \$9,750.00 = \$3,393.75)  
 One of the greatest values of cost analysis is that it brings into sharp focus the economics of a project or alternative.

## II. ASSESSING BENEFITS

### A. INTRODUCTION

An examination of benefits is important to the selection of an alternative or course of action. Cost alone is rarely the only factor examined. Costs are objectively measured in dollar terms. However, benefits may not even be directly quantifiable. Assessment and comparison of benefits across alternatives can be the most difficult portion of a cost-benefit analysis.

Generally speaking, a benefit is anything which is worthwhile or advantageous about an alternative and is of a non-cost nature. To an analyst, however, a benefit is an output, the result of implementing an alternative. Benefits can be pluses or minuses just like costs. Negative benefits which have an adverse impact are still termed benefits, even though in layman's terms they are disadvantages.

In performing a cost-benefit analysis, the analyst must make the distinction between costs and benefits. To the uninformed, cost savings would appear to be a benefit. To the mature analyst, costs are quantitative items analyzed separately under the cost section of a cost-benefit analysis. The important thing to remember is that a benefit is an output and a cost is an input.

### B. CONCEPTS

Benefits are clearly distinguishable from costs. Cost savings or cost reductions really are costs and are analyzed in the cost side rather than the benefit side of a true cost-benefit analysis. They are not outputs but are negative inputs. Benefits may be classified as one of two types - quantifiable or nonquantifiable. Some examples are listed below.

#### Quantifiable benefits:

- \* Faster system
- \* More RAM
- \* Faster printer
- \* Fewer ribbon changes
- \* Improved productivity (more forms processed)

Nonquantifiable benefits:

- \* Early availability
- \* Easy transition
- \* More hardware available
- \* Low capital investment
- \* Improved productivity (better morale for workers)

Compared to the status quo or current alternative, some alternatives may offer benefits which are distinctly less preferable than the current situation. When an alternative has negative benefits, other features such as reduced cost or other positive benefits must offset these.

C. IDENTIFYING BENEFITS

The most important thing to consider when identifying benefits of a project is that a benefit is an output. We would like our projects to have only good output but we know that all too often there can be bad or negative output as well. A new engine may improve gas mileage, run quieter, and last longer, but it may also cause more air pollution. In a case like this, the air pollution must be considered also.

Although cost savings, accrued from implementing a new alternative, are good and desirable events, an analyst must remember that they are not increased output but reduced costs. Cost savings can be used as a decision criteria between alternatives if the benefit calculations for each are equivalent.

D. TECHNIQUES FOR QUANTIFYING BENEFITS

The following techniques may be used to measure or quantify benefits and serve as indicators of desirability. These should be used if actual dollar figures cannot be identified.

1. Dollar quantifiable

Dollar quantifiable benefits are benefits which are measurable in terms of dollar magnitude (order of magnitude) but not measurable enough to be used as exact cost figures in the cost analysis portion of a cost-benefit analysis.

### Dollar Quantification of Potential Loss

<u>Alternative</u>	<u>Potential Loss</u>	<u>Term Definitions</u>
A	Large	Large: \$10-20 Million
B	Moderate	Moderate: \$3-4 Million
C	Moderate	Moderate: \$3-4 Million
D	Small	Small: \$1 Million or less

### 2. Units of output

The units of output generated under an alternative may be counted to give an indication of the alternatives desirability.

### Ranking by Units of Output

<u>Alternative</u>	<u>Units Produced per Hour</u>
A	127 units
B	107 units
C	100 units
D	47 units

### 3. Ratio or Index

An index gives a numerical ranking of the value of an alternative's value which is expressed in a common denominator, usually as a percentage.

### Ranking by Unit Index

<u>Alternative</u>	<u>Percent Complete</u>
A	100%
B	79%
C	39%
D	12%

#### 4. Rating scale

This involves rating the benefits and giving them a numerical ranking. The order of such a ranking only gives relative importance. If the benefits are nonquantifiable in any other way this method will usually work. The problem associated with this method is that it tends to be subjective in nature, the ranking must be made based on a person or persons' judgement.

#### 5. Narrative descriptions

These are narratives or written statements which describe the benefits associated with alternatives in sentence and paragraph format. If no other method above will work then this may be the only choice you have.

#### B. ILLUSTRATION

In the previous example, we looked at the costs of Old Not-So-Faithful versus El Cheapo Supreme. Now lets look at some of the benefits of each alternative.

Old Not-So-Faithful has room for four passengers, safety belts (which statistics say can save 75% more lives each year than not wearing safety belts), has a trunk that is 5'x4'x2' (40 cubic feet), but its last inspection shows that the level of toxic emissions is 20 parts per million. It still passes inspection but, as a pollution conscious citizen you are becoming concerned.

After some research, you uncover the following information about El Cheapo Supreme. It comes equipped with the latest in airbag safety equipment. Estimates are that such equipment can prevent 95% of fatalities caused by car accidents where no protection is available. The trunk has the dimensions 5'x5'x2' (50 cubic feet), the car has room for four comfortably or two adults and three children. The toxic emissions level of the new car are estimated to be under 1 part per million.

Lets compare the two alternatives.

	Old Not-So-Faithful	El Cheapo Supreme
<b>SAFETY</b>	75% improvement	95% improvement
<b>OCCUPANCY</b>	4 passengers	4 passengers
<b>POLLUTION</b>	20 ppm	< 1 ppm
<b>TRUNK *</b>	40 cu ft or 34.5 bags of groceries	50 cu ft or 43 bags of groceries



\* Because you are a pollution conscious citizen, you only use recyclable paper bags which are 7''x12''x13''. Each bag is 0.58 sq ft in bottom surface area. The trunk of Old Not-So-Faithful is 20 sq ft in floor surface area and the trunk of El Cheapo Supreme is 25 sq ft in floor surface area. Dividing 20 by 0.58 you get 34.48 (or 34.5) sq ft. By dividing 25 by 0.58 you get 43.1 (or 43) sq ft.

Examining the benefits, you see that El Cheapo Supreme is equivalent to or better than Old Not-So-Faithful in all categories.

### III. COST-BENEFIT ANALYSIS

#### A. INTRODUCTION

Like most good ideas, cost-benefit analysis is a simple concept. It provides a detailed examination of the costs of the proposed solution. It compares all the economic costs and benefits of a project over its lifetime discounted to the present time.

Cost-benefit analysis, because it is a quantitative approach to decision making, reduces the ambiguity found in normal everyday situations.

#### B. STEPS TO A COST-BENEFIT ANALYSIS.

Cost-benefit analysis involves the following six steps:

##### 1. Define Objectives/Goals -

The first step in solving any problem is to determine the goal that the group is trying to work toward. The goal set in a CBA is exactly the same as any other problem. It must describe a desired situation, an improvement on the current situation. It must have an identifiable output which can be measured to evaluate progress.

##### 2. Formulate Assumptions/Identify Constraints -

Once the goal is set, you must describe the conditions that the project is occurring in. There will be some constraints in the workplace that cannot be changed. Some things like the maximum number of hours available to do a job can't be changed without the use of overtime.

Other conditions may exist that cannot be explicitly defined. You may know that certain forms will continue to be processed but you may not know with certainty how many forms may need to be processed in future years. An assumption must be made about such situations. All such assumptions must be reasonable, logically thought out, and clearly explained.

##### 3. Identify Alternatives -

Once you have fully described the conditions that you are working under you can start identifying possible solutions. Using regular problem solving techniques, come up with as many suggestions as you can no matter how crazy or incomplete. You can weed out, combine or add to them later.

Next choose from your list those possible solutions that seem to meet the requirements of your goal. Remember, you will be analyzing them later but pick likely candidates now. Don't be surprised to find yourself adding new alternatives as the analysis progresses. Keep your original list around just in case some of them may be refined over time into reasonable alternatives.

#### 4. Quantify Costs/Benefits -

Using the techniques discussed in previous sections, quantify the costs and benefits. During this step it may become obvious that some methods clearly are not feasible or others may suggest themselves. Don't hesitate to add additional ideas, modify or combine, or delete those that are clearly unfeasible.

#### 5. Compare Cost and Benefits/Rank Alternatives -

After completing the calculations of costs and benefits for all alternatives it is time to compare the alternatives to determine the relative rank of each. These techniques are discussed in later sections.

Eliminate any alternatives that are clearly inferior (i.e. have a CB Ratio of less than 1.0 or are beaten in all areas by another choice. Rank any remaining alternatives in order of their relative efficiency.

#### 6. Evaluate Uncertainties -

By recalculating the costs and benefits after relaxing constraints or changing assumptions you can run sensitivity analyses to see how the alternative holds up in the face of uncertainty. You do not need to change every assumption or constraint, only those that you feel may not be representative of what the current situation really is. Or you may feel that something could change in the future.

When you do the sensitivity analysis you change only one assumption or constraint at a time to see how large a change is made in the resulting ranks of alternatives. If a reordering of the ranking of the alternatives takes place then a careful study must be made to see if the given situation is likely to occur.

#### C. STRENGTHS AND USES OF CBA

The original and most common use of CBA is to rank and compare alternative projects or alternative methods for achieving an objective. As you saw with the old car versus new car example, CBA is a good way to look at the economics of a choice or decision.

Another reason CBA is used is that Congress, DOD, and DA require a CBA to justify certain kinds of projects. This is usually done as part of a "feasibility study." Even in cases where no CBA is required by a higher authority, managers often ask for CBA's to help them make decisions.

A great advantage of CBA is that it compares costs and benefits purely in dollars and cents. A very large and complex analysis can usually be summarized in a few figures, and those figures are "the bottom line."

#### D. WEAKNESSES AND MISUSES OF CBA

You should be aware that there are some disadvantages to CBA, and it can be manipulated unfairly or misused. The biggest disadvantage of CBA is that it primarily considers economic factors. In the example of El Cheapo Supreme, some important psychological considerations can't be quantified. Will you enjoy driving a shiny new car instead of a rusty old one? Is the new car any more comfortable or any safer? These questions are often excluded from a CBA unless they affect the dollars and cents, and they usually don't.

In addition to this disadvantage, CBA also can be misused. The estimation of benefits and costs may be biased. A biased CBA might overstate the benefits by placing a very high value on some intangible benefit ("we estimate that improved morale will cause the productivity of the entire branch to rise 10%."). Or a biased study might deliberately underestimate the costs.

An additional weakness lies in the susceptibility to manipulation of the benefit-to-cost ratio (benefits divided by costs = ratio). Presumably, if a ratio is significantly above 1, say 1.5, the project would result in enough net benefits to justify moving ahead. But, since any ratio greater than 1.000 can be increased simply by subtracting an equal amount from the numerator and denominator, you can make your project appear more favorable.

#### EXAMPLE

If benefits = \$9000 and costs = \$8000, the benefit-to-cost ratio =

$$\frac{9,000}{8,000} = \frac{9}{8} = 1.125$$

But if someone subtracts \$2,000 from both the costs and the benefits, the ratio looks better:

$$\frac{9,000 - 2,000}{8,000 - 2,000} = \frac{7,000}{6,000} = \frac{7}{6} = 1.167$$

And if they subtracted \$6,000 from both costs and benefits:

$$\frac{9,000 - 6,000}{8,000 - 6,000} = \frac{3,000}{2,000} = \frac{3}{2} = 1.500$$

If questioned about these subtractions, the preparer might offer these rationalizations:

1. Since some costs (x,y,z) are the same for both alternatives, we will leave those out of the ratio.

2. Instead of treating x as a cost, we will treat it as a negative benefit and net it out from the numerator and denominator.

A third problem is related to the second. If the benefit-cost ratio could not be manipulated, then the project with the highest benefit-cost ratio would be the "best" project. That is, the most benefits would be obtained for your dollar if you chose the project with the highest ratio. But, unfortunately, ratios can be manipulated; therefore, the benefit-cost ratio is not an infallible guide for decisions.

If the ratio could be misleading, then why bother with it? Well, we bother with the ratio because you are in a position to know whether the benefit-cost ratio has been manipulated on your project. If the benefits of all the alternatives have been fairly and conservatively estimated, and the "costs" of each alternative represent the actual amounts you would have to spend, then the benefit-cost ratio is the one which will yield the most benefits per dollar spent.

However, you must be aware that the highly touted cost-benefit ratio of some other project (which may be competing with yours for funds) cannot be taken at face value. Armed with your natural suspicion and knowledge of how ratios are manipulated, you can perhaps detect a "pumped up ratio."

You should inquire about others:

- What is the nature of the benefits?
- Are they tangible?
- How were they quantified?
- Does "cost" reflect the total outlay by the organization?
- Are there any costs or negative impacts in other organizations/activities if this project is approved?

One other point should be kept in mind about benefit-cost ratios; they can properly be used to compare alternatives, or they can be used to decide whether a project is worth doing. Those uses should not be confused.

## E. FORMULAS FOR COMPARING ALTERNATIVES

### END-OF-YEAR FACTORS

ASSUMPTIONS:  $i$  = annual interest rate in decimal form;  
 $n$  = number of years;  
 $P$  = present amount;  
 $F$  = future amount;  
 $A$  = annuity or amortized amount

1. Single-payment Compound Amount (CA) Factor:  
the number of dollars which will have accumulated after  $n$  years  
for \$1 dollar initially invested at a rate of  $i$  percent;  
 $(F/P, i\%, n): (CA) = (1+i)^n$
2. Single-payment Present Worth (PW) Factor:  
the amount one must initially invest at  $i$  percent to have \$1  
after  $n$  years;  
 $(P/F, i\%, n): (PW) = 1/((1+i)^n)$
3. Sinking Fund (SF) Factor:  
the amount one must invest in uniform amounts at  $i$  percent at the  
end of each of  $n$  years to accumulate \$1;  
 $(A/F, i\%, n): (SF) = 1/(((1+i)^n)-1)$
4. Capital Recovery (CR) Factor:  
the amount one can withdraw in equal amounts at the end of each  
of  $n$  years if \$1 is initially deposited at  $i$  percent interest;  
 $(A/P, i\%, n): (CR) = (SF) * (CA) = \frac{i*((1+i)^n)}{((1+i)^n)-1}$
5. Series Compound Amount (SCA) Factor:  
the number of dollars which will be accumulated if exactly \$1 is  
invested at  $i$  percent at the end of each of  $n$  years;  
 $(F/A, i\%, n): (SCA) = 1/(SF) = \frac{((1+i)^n)-1}{i}$
6. Series Present Worth (SPW) Factor:  
the number of dollars one must initially invest at  $i$  percent to  
withdraw \$1 at the end of each of  $n$  years;  
 $(P/A, i\%, n): (SPA) = 1/(CR) = \frac{((1+i)^n)-1}{i*((1+i)^n)}$

Given	To Find	Use
$P$	$F$	CA
$F$	$P$	PW
-----		
$P$	$A$	CR
$A$	$P$	SPW
-----		
$F$	$A$	SF
$A$	$F$	SCA

**F. COMPARISON CRITERIA**

1. Payback - amortize the investment to see how long the period would be before you get back what you invested.
2. Internal Rate of Return - return on investment.
3. Maximum Benefits - choose the alternative which has the highest benefits, cost is not a consideration.
4. Benefit/Cost Ratio - most benefits per dollar expended.
5. Maximize Net Benefits - return the most benefits after costs are netted out.
6. Minimize Annualized Cost - need to minimize costs of project.
7. Net Present Value - present worth of benefits over costs. What is left in present value terms after you subtract costs.

		BENEFITS	
		EQUAL	UNEQUAL
COSTS	EQUAL	other factors besides tangibles	highest benefit
	UNEQUAL	lowest cost	criteri(a)on

## **VI. PRACTICAL EXERCISES**

Cost Analysis Division, Directorate for Resource Management, is considering replacing its current inventory of Wyse personal computers used to perform analysis work. A summary of the costs and benefits attendant to the current system and the two potential alternatives is displayed below. For sake of brevity, not all costs or benefits may be present. An analysis of the data in light of sections IIIA-D is the object of this example.

**Cost and Benefit Summary:**

	Wyse Computer Co Model 2751	Crawford Computer Co Model 3318	Madden Systems Co Model 2001
Price	\$1795	\$1295	\$2400
Yearly Maint	\$142	\$311	\$117
Sustain	\$53	\$42	\$100
Speed	286	386	386
Ease of Use	EASY	VERY EASY	AVERAGE
Down Time	6 MO/YR	4 MO/YR	8 MO/YR
Size	MEDIUM	SMALL	MEDIUM

**\* Nonquantifiable benefits:**

- [1] Wyse computer well supported by manufacturer nationwide.
- [2] Crawford computer has no nonquantifiable advantages.
- [3] Madden computer processes financial data much more rapidly during year-end closing and when under the scrutiny of Army Auditors.

Using the techniques discussed in this handbook, which computer would you recommend?



## V. GLOSSARY

Alternative - One of two or more methods of achieving a desired objective. The current situation is always an alternative.

Annuity - A uniform series of payments over time.

Assumption - An estimate concerning unknown factors and data which are made and applied throughout the analysis whenever facts are not available. Assumptions should never be confused with facts and will not be used when facts are available. They will be explicitly identified and explained with supporting rationale.

Baseline Cost Estimates (BCE) - The Baseline Cost Estimate is the first deliberate, detailed, and complete cost estimate made for a new system. This estimate will address acquisition and operating costs and will be the baseline for all subsequent tracking and auditing purposes. A Work Breakdown Structure (WBS) will be established concurrently with the baseline estimate. If one already exists, it will be used. Discrete cost elements, cost parameters, and the recommended "design-to" unit production cost(s) will be included in the Baseline Cost Estimate.

Base Year - The first year (year of reference) for an index. The index is 1.0000 in this year and changes each succeeding year.

Benefits - Results expected in return for costs incurred in terms of the objective. (Cost savings or cost avoidances are reductions in required resources, or inputs, and are not benefits, or outputs.) Benefits can be negative.

Benefit Analysis - Systematic discovery and quantification of all relevant benefits of each alternative with a goal of consistent measurement for ranking the relative benefits of each alternative.

Constant Dollars - A cost or budget estimate in constant dollars is an estimate which has not been inflated. Any year's dollars may be used as the base year. For example, an estimate can be in FY87 or FY89 constant dollars (prices).

Constraint - External barriers which provide boundary limitations to be considered in developing, analyzing, and evaluating alternatives.

Cost - The value of economic resources such as manpower, equipment, real facilities, supplies, and all other resources necessary to achieve an objective. Measured in dollars.

Cost Avoidance - Savings that eliminate the need to apply additional resources to accomplish output.

Cost-Benefit Analysis (CBA) - An analysis that compares the resources required to adopt a particular course of action with the anticipated benefits or results. The approach involves a definition of objectives and alternatives, and what each alternative will yield in benefits. Often used interchangeably with economic analysis or cost-effectiveness analysis.

Cost-Benefit Ratio (or Benefit-To-Cost Ratio) - The ratio expressed by dividing costs into benefits. This ratio is used to identify the rank of the alternatives in terms of efficiency. A cost-benefit ratio of less than 1.0 indicates that costs of a project are greater than the benefits attained. If the ratio is greater than 1.0 the project would result in net benefits to make implementation worthwhile.

Cost Categories - The major divisions of weapon/support systems' costs from inception to retirement of the system. These are:

a. Research and Development (R&D) - This category includes those costs resulting from applied research, engineering design, analysis, development, and testing which can be related to a specific weapon/support system WBS component. The effort from which these costs derive usually occurs within advanced development, engineering development, and operational systems development of the R&D cycle.

b. Investment - This category contains those cost elements which occur as a result of the size of the production buy or occur repeatedly in the production of a weapon/support system or its components. The buy will include end items (generally level II equipment) projected for replacement due to wear-out during the total life cycle of the weapon support system.

c. Operating and Support Costs - This category includes those costs resulting from the operation, maintenance, and consumption of materials and supplies for a weapon/support system after acceptance into the Army inventory.

Cost-Effective Alternative - The alternative which provides the greatest degree of effectiveness with consideration of the resources required for implementation.

Cost-Effectiveness Analysis - The quantitative examination of prospective alternatives for the purpose of identifying the preferred alternative. The process of comparing alternative solutions to requirements in terms of the value received (effectiveness) for the resources expended (costs).

Cost Estimate - The estimated cost of a component or aggregation of components. The analysis and determination of cost of equipment and interrelated activities is cost analysis. Costs in a cost analysis usually fall into one of three basic categories: Research and Development, Investment, or Operating and Support Costs.

**Cost Growth** - Cost Growth is a term related to the net change of an estimated or actual amount over a base figure previously established. The base must be relatable to a program, project, or contract and be clearly identified including source, approval authority, specific items included, specific assumptions made, date, and amount.

**Cost Overrun** - A cost for a system which is larger than the amount budgeted due to management oversight or miscalculation. The cost overrun is the difference between the cost and amount budgeted.

**Cost Validation** - The examination of all elements of a cost estimate to determine if it is accurate and reasonable: e.g., the soundness of computational methods, reasonableness of assumptions, and completeness.

**Discount Rate** - The interest rate used to calculate the present value of future cash flows.

**Discounting** - A technique for converting various cash flows or cost streams to economically comparable amounts at a common point in time, considering the time value of money.

**Economic Analysis** - A systematic approach to the problem of choosing how to employ scarce resources and an investigation of the full implications of achieving a given objective in the most efficient and effective manner.

**Effectiveness** - The degree to which alternatives reach the given objective or, in other words, how well a given system or alternative performs its intended function.

**Efficiency** - The manner in which the resources available are used. The goal is to gain the greatest amount of output from the alternative systems for the least amount of input.

**Future Value** - The worth of a current cash flow if it occurred at a point in the future.

**Independent Cost Value** - An estimate of program cost developed outside normal advocacy channels by a team which generally includes representation from the functional areas of cost analysis, procurement, production management, engineering and program management.

**Nonguantifiable Benefits** - Benefits which cannot be measured in terms of specific units. Also called Intangible Benefits.

**Objective** - Goals or results that the decision-maker wants to attain.

**Operating and Support Costs** - A life cycle cost term covering the cost of operating and supporting a system from initial operational capability (IOC) for a given period of years.

**Outputs** - Goods and/or services produced from a particular course of action. Also called benefits.

Parametric Estimating - Parametric estimating is an estimating technique which employs one or more cost estimating relationships for measurement of costs associated with the development, manufacture, and/or modification of a specified end item, based on its technical, physical, or other characteristics. Also may be used to develop estimates for physical or performance characteristics.

Present Value - The worth of future cash flows if they occurred today. The present value of future cash flows is determined through the techniques of discounting.

Price - Refers to the dollar value a company will sell its product for or commit to a contract. Includes profit or fee added to cost.

Profit - Generally characterized as the basic motive of business enterprise. The excess of the revenues from sales of goods or services over the related cost thereof in a given transaction or over a given period of time. The word "profit" is used in fixed price type contracts versus "fee", in cost type contracts.

Recurring Costs - Repetitive production costs that vary or occur with the quantity being produced.

Return on Investment (ROI) - Also rate of return. The discount rate (percentage) at which the present worth of the savings is equal to the present worth of the investment.

Risk - A state in which the ultimate outcome is unknown, but in which all possible outcomes can be enumerated and probabilities assigned to each.

Savings - A reduction in expense, time, labor, or material, expressed in dollars.

Savings to Investment Ratio (SIR) - The ratio of discounted operating cost savings to the discounted cost of the investment required to produce the savings.

Sensitivity Analysis - A technique employed for the evaluation of uncertainty in an analysis. The procedure is to vary the value of a particular parameter and examine the extent to which this change affects the results of the analysis.

Status Quo - The current state of affairs. The status quo is always an alternative to be considered.

Sunk Cost - A cost which is irrevocably committed to a project; such costs have no bearing on the results of comparative cost studies, except for program evaluations.

Uncertainty - A situation where more than one ultimate outcome is possible.